Barriers and Facilitators to Mediterranean Diet Adoption by Patients with Non-alcoholic Fatty Liver Disease in Northern Europe

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Abstract

Background & Aims: Dietary interventions for weight loss are effective therapies for non-alcoholic fatty liver disease (NAFLD). The Mediterranean diet might benefit these patients but it is not followed consistently in Northern European countries. We examined factors that determine Mediterranean diet adoption and maintenance in a northern European population.

Methods: We used a mixed-methods approach to investigate the effects of a 12-week Mediterranean diet intervention and perceived barriers and facilitators. Nineteen adults with NAFLD were recruited from a tertiary hepatology center in England. Participants were taught behavioral strategies through the provision of shopping lists, meal planners, and recipes; no advice was given on calorie allowances or physical activities. We used the 14-point Mediterranean diet assessment tool to assess dietary intake, based on a small number of foods in servings/day or servings/week, at baseline and after 12 weeks; participants were assigned scores of low (less than 5 points), moderate (6–9 points), or high (10–14 points). Semi-structured interviews were audio recorded, transcribed, and analyzed using the framework method.

Results: Twelve weeks after the dietary advice, Mediterranean diet adoption significantly increased from moderate to high (mean increase of 2.2 points; from 7.6±2.5 at baseline to 9.8±2.8 at 12 weeks) (*P*=.006). This increase was associated with a mean reduction in bodyweight of 2.4 kg (from 99.2 kg±17.0 at baseline to 96.8 kg±17.5 at 12 weeks) (*P*=.001) and increased serum concentrations of high-density lipoprotein cholesterol in 72% of participants (from 1.10±0.8 at baseline to 1.20±1.30 vs. 1.00±0.5 at 12 weeks) (*P*=.009). Increased nutrition knowledge and skills, family support, Mediterranean diet promotion in media and clinical settings, and the nutritional care facilitated diet changes. Barriers to Mediterranean diet uptake included an obesogenic environment, life stressors, and demand for convenience. Poor understanding of the causes and significance of NAFLD adversely affected readiness to change dietary habits.

Conclusion: In an analysis of patients with NAFLD the northern United Kingdom, we found a 12-week Mediterranean diet intervention was acceptable and associated with significant reductions in bodyweight and increased serum levels of high-density lipoprotein. We identified barriers and

facilitators that could support appropriate treatment adaptations and guide personalized intervention approaches.

KEY WORDS: MDPS; HDL; metabolic liver disease; scalable diet treatments

Introduction

Non-alcoholic fatty liver disease (NAFLD) affects up to 1-in 3-people, driving the global epidemic in chronic liver disease and consequent healthcare resource utilization (1, 2). NAFLD is a spectrum that encompasses isolated hepatic fat accumulation (steatosis, NAFL); through fat plus inflammation and hepatocyte injury (non-alcoholic steatohepatitis, NASH); ultimately to fibrosis/cirrhosis and potentially hepatocellular carcinoma (3-5). NAFLD is strongly associated with obesity and Type 2 diabetes and is an independent risk factor for the development of cardiovascular disease (CVD) (3).

Lifestyle interventions are the cornerstone of treatment in the absence of effective pharmacotherapy. The exclusion of processed food and fructose is effective and calorie restrictions to achieve 7-10% weight loss improve clinical biochemistry, histological steatohepatitis and fibrosis (6-8). The Mediterranean diet has been shown to ameliorate steatosis and improve insulin sensitivity/glucose tolerance, independent of weight loss (8-10).

The factors that determine Mediterranean diet adoption in a northern European patient population are largely unknown. There is scarce evidence on the barriers and facilitators that influence an individual's decision to adopt, and ability to maintain, such a diet long-term. There is limited information on whether an individual's understanding of their underlying liver disease contributes to the adoption of a diet intervention or their perceptions of nutritional care. These data will be highly relevant to the development of scalable diet treatments.

The aim of the current study was, firstly, to determine key barriers and facilitators to adoption and maintenance of a 12-week Mediterranean diet intervention; and, secondly, to identify which adaptations would optimize treatment delivery and so maximize dietary behavior change.

Materials and methods

This mixed-methods study was informed by a multi-disciplinary team comprising dietitians, psychologists and medical staff. The aim was to explore participant's experiences of following a 12-week Mediterranean diet intervention. Semi-structured interviews were conducted to identify barriers and facilitators to diet uptake and maintenance. Socio-demographic data and routinely measured clinical and lifestyle variables were collected with preliminary changes reported. The information was then integrated into the discussion of the overall results.

Recruitment

Patients were recruited from a specialist NAFLD clinic at a tertiary hepatology center, The Newcastle upon Tyne Hospitals NHS Foundation Trust, which covers a broad geographical area in Northern United Kingdom. Eligibility criteria included capacity to provide informed written consent, and ability to write and converse in English without an interpreter. Inclusion criteria: 18-75 years old with NAFLD, weekly alcohol consumption<14/21 units in the last 24months, non-smoker. Exclusion criteria: liver cirrhosis or neoplasm, prescribed other diet therapies, food intolerances and/or allergies. The study protocol was approved by East Midlands–Nottingham 1 Research Ethics Committee (REC reference 15/EM/0049). Informed written consent was obtained.

Patients were identified by clinicians during routine appointments and invited to participate. Overall, a purposive sample of 20 patients with diverse socio-demographics were recruited. The target sample size was informed by the researchers prior experience and other qualitative studies where data saturation is typically achieved between 12 and 20 participants (11, 12).

Mediterranean diet intervention

Mediterranean diet intervention combined nutrition counselling and education delivered in a single-session by a dietitian. The intervention was based on the Mediterranean diet pyramid, a flexible model of dietary restraint (13). Behavioral strategies of goal setting, action-planning and self-

monitoring were targeted through the provision of shopping lists, meal planners and recipes. No advice was given on calorie allowances or physical activities. There was no further nutritional care provided over the 12 weeks, which reflects the standard follow-up interval in routine practice.

Quantitative data collection and analysis

Socio-demographic characteristics included age, gender, ethnicity, weekly gross equalized household income and marital status. Although the study was not powered to detect change in outcomes, key clinical and lifestyle variables ((blood lipids, bodyweight, and body mass index (BMI)) were monitored and presented. The 14-point Mediterranean diet assessment tool (MDPS) measured diet intake based on a small number of foods in servings/day or servings/week. The range of possible scores are 0-14; low, moderate or high consumption respectively ($\leq$5, 6-9 and $\geq$10points) (14).

Descriptive and inferential analyses were performed in SPSS (version 22) alpha $p<0.05$. Continuous and categorical data summarized as ((mean, standard deviation (SD) and counts (percentage)). Paired t-tests were used to assess changes in clinical and lifestyle data between baseline and study end for continuous variables. Mann-Whitney U test was used to assess if clinical and lifestyle data differed by the semi-categorical diet adoption score (MDPS).

Qualitative data collection and analysis

Face-to-face semi-structured interviews were completed after 12 weeks by a nutrition worker trained in qualitative research methods, audio-recorded and transcribed verbatim (interview schedule, Supplementary Material Table 1). Design and reporting was informed by consolidated criteria for reporting qualitative research (15). Reflexivity was fostered by involving multiple researchers and using a diary to record impressions of the data and analysis process.

The framework method was used for thematic analysis of the transcripts (16). Two researcher's independently coded the same 40% of transcripts to develop a working analytical framework. These initial findings were discussed during meetings to resolve any discrepancies. This process was replicated with an additional 20% of transcripts, producing further iterations of the framework. Coding involved reading and re-reading transcripts, and coding the content into themes and subthemes until no further codes emerged.

A third researcher was consulted to refine the framework and ensure consensus was reached on themes and subthemes. This triangulation of expertise captured different perspectives and enhanced trustworthiness of the findings. The framework was then applied by indexing the remaining transcripts using the existing categories and codes, until data saturation occurred at 19 transcripts. The summarized abstracted data was charted into a matrix for each final theme. Direct participants quotes are reported to support themes and thus maximize confirmability.

Results

One participant left the study following a major change in social circumstances, unrelated to participation so the final sample comprised 19 participants. Baseline characteristics are presented in Table 1. Median weekly gross equalized household income was £320.5 (£76.9 to £1249.9), approx. €364.7 (€87.5 to €1422.4). All participants had clinically significant NAFLD: 16 had biopsy proven NASH with Kleiner fibrosis stages ranging between F1-3. The other 3 patients had clinical and radiological evidence of NAFLD with intermediate-range NAFLD fibrosis scores (>-1.445).

After 12-weeks diet intervention, Mediterranean diet adoption significantly increased from moderate to high levels (mean increase of 2.2 points; 7.6±2.5 at baseline to 9.8±2.8 at 12 weeks) (p=.006) (Fig.1). In parallel, 79% of participants reduced bodyweight by mean 2.4kg (from 99.2kg±17.0 at baseline to 96.8kg±17.5 at 12 weeks) (p=.001) (Fig.2). Participants with improved diet uptake (72%) had increased high-density lipoprotein (HDL) cholesterol (1.10±0.8 to 1.20±1.30

vs. 1.00±0.5) (p=.009). No association between diet adoption and socio-demographics were observed.

Interview data are described with participants identified by gender and age only. Figure 1 provides the analytical framework for themes, subthemes, barriers and facilitators. The links between quotes and the framework are presented (Supplementary Material Table 2).

NAFLD conceptualization

Poor understanding about NAFLD appeared to influence the priority placed on following dietary advice. NAFLD was not well-defined and knowledge of the potential to induce disease regression/reduce progression was limited. Illness-related demands were perceived as lethargy, discomfort, pain, bloating, anxiety, disordered temperature regulation and altered immunity. Conversely, several reported no symptoms, or attributed symptoms to diabetes or ageing.

NAFLD causality and the strength of these associations produced responses that incorporated physiological drivers, lifestyle behaviors and genetic predisposition. The absence of alcohol in disease development was stressed. Poor diet and excess weight were often viewed as causal, and the regional cultural identity as influential. Conversely, the diet-disease relationship and impact of excess weight was questioned by a few participants.

“I understand that if I lose weight, it might improve it. I’m struggling to be convinced by that.” (F, 55 years 05)

NAFLD specific self-care priorities and acceptance for dietary self-control was imperceptible. Although, it was generally recognized that high-quality dietary patterns improve life expectancy and health outcomes. In some cases personal healthy dietary behaviors were shared to

emphasize that further dietary changes weren't needed. Participants were less likely to engage in the change process if they interpreted their habitual diet as either low or high Mediterranean.

"Well, I haven't had to make many changes, so it's not been a challenge. I've just been more aware." (F, 55 Years 05).

The process of dietary behavior change

Readiness and psychological factors

Placing high value on potential health benefits and the expectation of dietary enjoyment increased participants' readiness to change their habitual diet. Improved Mediterranean diet adoption was linked to responses portraying self-determination and high intrinsic motivation. Conversely, difficulties were related to perceived helplessness and increased demand for food skills.

"Yes, I want to change; I'm finding it hard to change, but I want to change. I'm a creature of habit." (F, 38 years)

Higher internal locus of control–belief in one's own ability to control events-assertiveness and a balanced relationship with food supported diet modifications. Stressful experiences, ambivalence and optimistic bias hindered the process. High responsiveness to cues outside of hunger, resulting in treats, cheats or rewards were obstacles to following dietary advice. Attitudes diverged on whether it was feasible to consume Mediterranean diet across seasons.

"When I left work this afternoon I walked into the administration office I saw the big bag of Maltesers® there made up of little bags. I know I shouldn't, but I did." (M, 59 years)

"Then Christmas came in the middle of it, and Christmas just isn't geared up for the Mediterranean diet, really, is it?" (F, 38 years)

Practical and social

Mediterranean diet intervention was highly acceptable to many participants with impressions of food abundance, variety and enjoyment. The cost of Mediterranean diet ingredients did not emerge as an obstacle to participants following this dietary pattern. Portion sizes were typically considered adequate and a range of individual Mediterranean foods were consumed. Enhanced nutrition knowledge/skills and self-regulation supported diet uptake.

"I'm just amazed at how much fruit and vegetables you can buy for quite a low amount of money." (M, 59 years)

Participants encountered difficulties with an obesogenic environment and a societal pressure to consume. The unhealthy selections available in institutions, workplaces and supermarkets negatively impacted diet maintenance. Work patterns and dietary habits were problematic for appetite regulation and food routines. In contrast, easy access to budget supermarkets, good transport links and having family diet supporters were regarded positively.

"I always bring my food with me, which makes me look a bit like an outsider. So, I have to fight my corner." (F, 55 years 05)

Dietary management

Personalized approaches combining nutrition education and counselling skills induced diet modifications. The dietitian was considered an advocate of flexible dietary restraint and the Mediterranean style of eating. The importance of role modelling and credibility was identified. Participants reported food selections based on therapeutic benefits with nutritional quality, freshness and palatability. However, taste preferences were a clear barrier in some cases and sustained dietary changes also appeared dependent upon improvements in clinical parameters.

79% of participants achieved weight reduction. These individuals largely perceived the adoption of the diet as more feasible, conveying a greater magnitude of dietary changes.

(F, 55 years 04) reduced her weight by 5.6kg and said *"I would want them to know it's really easy. It's very enjoyable, and a variety of foods." "There is enough food you can eat."*

Conversely, in those cases where weight loss was not attained, difficulties applying dietary changes were more often reported.

(F, 38 years) gained 2.3kg and stated *"What I found hard was, because I rely quite a lot on convenience, preparing everything from scratch, you weren't able to just grab something and go you had to think about it."*

Treatment adaptations

Measures to shape future diet interventions were suggested, such as joint creation of resources and personalized dietary input on a quarterly basis. Face-to-face contacts were preferred with support from an online program, thus enabling housebound patients and those from a wider geographical area to engage. Telephone contacts appeared to be least helpful and groups cost-effective and motivating. Mediterranean diet promotion in clinical settings and increased coverage in books and television facilitated diet uptake.

Discussion

The Mediterranean diet is widely studied and has beneficial properties in a broad range of diseases (17, 18). The PREDIMED study reported that high Mediterranean diet adoption (MDPS ≥9), was associated with significantly lower odds ratios for obesity prevalence and CVD risk. Furthermore, a 2-point increase in MDPS was associated with reduced risk of ill-health (19, 20). Our results are consistent with emergent evidence within the NAFLD population (21).

Mediterranean diet adoption significantly increased and was associated with modest but significant bodyweight reduction and increased HDL-cholesterol in participants. These findings suggest this dietary pattern alongside other lifestyle changes contribute to an improved CVD risk profile in NAFLD patients.

Perhaps unsurprisingly, Mediterranean diet consumption was lower in the study population (MDPS 7.6±2.5) than in a Mediterranean population (MDPS 8.7±2.0) (20). Accordingly, Mediterranean diet interventions outside the Mediterranean region may face additional challenges and warrant specific approaches. Interestingly, we identified no association between socio-demographic characteristics at baseline or end-of study MDPS, though the ability to detect associations may have been impeded by small numbers.

Barriers and facilitators of Mediterranean diet adoption and maintenance

NAFLD conceptualization

Acceptance of NAFLD as a disease and nutritional care engagement is impacted by patients understanding of their condition. Poor health service utilization may be in part attributed to lack of symptoms, and viewing long-term diseases and their outcomes as inevitable (22, 23). Therefore, clinicians should stress that NAFLD is treatable and even reversible if diet improvements are sustained (6). Perceived stigma in obesity and liver disease poses psychological burden. In this study, the absence of alcohol in NAFLD causality, social desirability and optimistic bias was emphasized.

Readiness and psychological factors

Participants readiness to change, underpinned diet adoption and maintenance with low intrinsic motivation and ambivalence obstacles to following dietary advice. This is consistent with recent findings that willpower and willingness to change affect healthy eating adoption (24-26). Self-efficacy is one of the best psychological predictors of good outcomes in lifestyle interventions that

target obese adults, but is low in NAFLD patients compared to other liver disease patients (27, 28).

Self-regulation and higher autonomous motivation have been found to be positive predictors of diet adherence in obesity interventions, which is in line with our findings (29). The negative impact of treats or rewards, and life stressors were evident and appear common in interventions targeting obese adults (28). Thus, having a balanced relationship with food is pivotal to success as well as the ability to manage moods, emotions and stressors.

Dietary management

Tangible markers of weight loss, improved glycemic control and well-being expedited diet maintenance. Our data supports the view that individuals with weight loss found the adoption of the diet more straightforward, as evidenced by the diet modifications reported. Published data indicates early weight loss is a prominent predictor of treatment adherence among obese patients and subsequent weight loss (28, 30). Trust in the dietitian–patient relationship encompassing; professional credibility; role modelling; and diet advocacy induced changes. Participants want effective personalized interactions and not standardized approaches.

Nutrition knowledge was significantly associated with Mediterranean diet adherence and lower obesity prevalence among the Molise population, Italy (MOLI-SANI study) (31). Nutrition counselling interventions have also been shown to induce moderate diet improvements previously (32). Hence, nutrition education and counselling are crucial ingredients in diet interventions. Although, more intensive approaches may have greater effectiveness than brief interventions (24).

Practical and social factors

One of the most significant findings in our study is that the Mediterranean diet is an acceptable healthy eating model in a non-Mediterranean country (24, 33). There were impressions of cost

neutrality, despite the study population having a mean weekly household income that is £227.4, approx. €258.8 lower than the UK average (34). Furthermore, previous research found diet changes did not equate to significantly increased purchase costs (1-point increase MDPS equivalent to £0.55) (24), which is supported by published cost analysis (35, 36).

Commitment to a diet intervention amongst other obligations appears demanding. Diet saboteurs and spousal conflict impacted the home environment to undermine food routines. Consistent with our data, research that examined barriers to healthy eating adoption also identified time pressures, busy lifestyle, irregular working hours and desire for convenience (37).

Treatment adaptations

The various treatment adaptations suggested underscores the futility of a one-size-fits-all approach. The joint development of intervention tools between patients and clinicians may optimize treatment adoption and maintenance. Personalized dietary input on a quarterly basis combined with an online program was also favored. Earlier intervention studies have used these components effectively (38).

The MOLI-SANI study reported that exposure to mass media information was significantly associated with greater adoption of a Mediterranean-style diet (41). Furthermore, that participants found increased coverage in media, books, magazines and television induced dietary behavior change, which is consistent with our findings.

The main limitation of the current study is potential for selection bias, with participants perhaps more health-motivated and interested in the diet intervention, which might not be applicable to the wider NAFLD population. However, steps were taken to address transferability by recruiting a purposive sample of individuals with diverse socio-demographics and making connections to the regional cultural and social context. Further larger studies are needed to assess Mediterranean

diet uptake and its impact in a larger population. Another limitation was that a detailed assessment of Mediterranean diet impact on markers of liver function was not conducted. However, this study primarily focused on identifying barriers and facilitators to a Mediterranean diet in patients with NAFLD, rather than assessing its impact on the liver, which has already been subject to a controlled trial (9). The sample size may be considered small in an epidemiological context, but was sufficiently robust to achieve the aims of this mixed-methods study.

Despite these limitations, this study adds to the body of literature indicating that a Mediterranean diet was highly acceptable, and its adoption was associated with positive clinical outcomes. The findings provide simple ways in which clinicians can optimize patient consultations in clinical practice. This study is the first to explore the factors that influence Mediterranean diet adoption in a northern European NAFLD patient population and demonstrates its potential to be translated in regions that consume a typical western diet. Importantly, no specific advice on calorie allowances or physical activities was given during the intervention and this still led to positive effects on bodyweight and HDL levels.

A 12-week Mediterranean diet intervention was acceptable in NAFLD patients and was associated with positive changes in bodyweight and serum HDL levels. The Mediterranean diet intervention effectively modified diet adoption and maintenance in a northern European patient population. Furthermore, during dietary intervention we identified a range of perceived barriers and facilitators, which may enable a more targeted and personalized intervention approach. Treatment adaptations to enhance personalized nutritional care were highlighted alongside the benefits of sustained exposure to Mediterranean diet information in media and clinical sources.

REFERENCES

1. Younossi ZM, Koenig AB, Abdelatif D. Global epidemiology of nonalcoholic fatty liver disease-Meta-analytic assessment of prevalence, incidence, and outcomes. Hepatology 2016;64:73-84.
2. Younossi Z, Anstee Q, Marietti M, et al. Global burden of NAFLD and NASH: trends, predictions, risk factors and prevention. Nature reviews. Gastroenterology and hepatology 2017;in press.
3. Anstee Q, Targher G, Day C. Progression of NAFLD to diabetes mellitus, cardiovascular disease or cirrhosis. Nature reviews. Gastroenterology and hepatology 2013;10:330-344.
4. Younes R, Bugianesi E. Should we undertake surveillance for HCC in patients with NAFLD. Hepatology 2017;68:326-334.
5. Pocha C, Kolly P, Dufour J. Nonalcoholic Fatty Liver Disease-Related Hepatocellular Carcinoma: A Problem of Growing Magnitude. Seminars in Liver Disease 2015;35:304-317.
6. Vilar-Gomez E, Martinez-Perez Y, Calzadilla-Bertot L, et al. Weight Loss Through Lifestyle Modification Significantly Reduces Features of Nonalcoholic Steatohepatitis. Gastroenterology 2015;149:3673–3678.
7. Promrat K, Kleiner D, Niemeier H, et al. Randomised controlled trial testing the effects of weight loss on nonalcoholic steatohepatitis. Hepatology 2010;51:121-129.
8. European Association for the Study of the Liver, European Association for the Study of Diabetes, European Association for the Study of Obesity. EASL–EASD–EASO Clinical Practice Guidelines for the management of non-alcoholic fatty liver disease. Hepatology 2016;64:1388-1402.
9. Ryan M, Itsiopoulous C, Thodis T, et al. The Meditteranean diet improves hepatic steatosis and insulin sensitivity in individuals with non-alcoholic fatty liver disease. Hepatology 2013;59:138-143.
10. Shai I, Schwarzfuchs D, Henkin Y, et al. Dietary Intervention Randomized Controlled Trial (DIRECT) Group.Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. New England Journal of Medicine 2008;3:229-241.
11. Crouch M, McKenzie H. The logic of small samples in interview-based qualitative research. Social Science Information 2006;45:18.
12. Guest G, Bunce A, Johnson L. How many interviews are enough? An experiment with data saturation and variability. Field Methods 2006;18:24.
13. Bach-Faigh A, Berry E, Lairon D, et al. Mediterranean diet pyramid today. Science and cultural updates. Public Health Nutrition 2011;14:2274-2284.
14. Martínez-González M, García-Arellano A, Toledo E, Salas-Salvadó J, Buil-Cosiales P, Corella D, et al. A 14-item Mediterranean diet assessment tool and obesity indexes among high-risk subjects: the PREDIMED trial. PloS ONE 2012;7:43134.
15. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Health Care 2007;19:349-357.
16. Ritchie J, Spencer L: Qualitative data analysis for applied policy research in A. Bryman and R. G. Burgess, Analyzing qualitative data. In. London: Routledge, 1994.
17. Sofi F, Abbate R, Gensini G, et al. Accruing evidence on benefits of adherence to the Mediterranean diet on health: an updated systematic review and meta-analysis. American Journal of Clinical Nutrition 2010;92:1189-1196.
18. Sofi F, Macchi C, Abbate R, et al.. Mediterranean diet and health status: an updated meta-analysis and a proposal for a literature-based adherence score. Public Health Nutrition 2013:1-14.
19. Salas-Salvado J, Bullo M, Babio N, et al. Reduction in the incidence of type 2 diabetes with the Mediterranean diet: results of the PREDIMED-Reus nutrition intervention randomized trial. Diabetes Care 2011;34:14-19.
20. Estruch R, Ros E, Salas-Salvado J, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. New England Journal of Medicine 2013;368:1279–1290.

21. Zelber-Sagi S, Salomone F, Mlynarsky L. The Mediterranean dietary pattern as the diet of choice for non-alcoholic fatty liver disease: Evidence and plausible mechanisms. Liver International 2017;37:936-949.
22. Zelber-Sagi S, Bord S, Dror-Lavi G, et al. Role of illness perception and self-efficacy in lifestyle modification among non-alcoholic fatty liver disease patients. World Journal of Gastroenterology 2017;23:1881–1890.
23. Mlynarsky L, Schlesinger D, Lotan R, et al. Non-alcoholic fatty liver disease is not associated with a lower health perception. World Journal of Gastroenterology 2016;22:4362–4372.
24. Lara J, McCrum L, Mathers J. Association of Mediterranean diet and other health behaviours with barriers to healthy eating and perceived health among British adults of retirement age. Maturitas 2014;79:292-298.
25. Kearney J, McElhone S. Perceived barriers in trying to eat healthier—results of a pan-EU consumer attitudinal survey. British Journal of Nutrition 1999;81:133-137.
26. Appleton K, McGill R, Neville C, et al. Barriers to increasing fruit and vegetable intakes in the older population of Northern Ireland: low levels of liking and low awareness of current recommendations. Public Health Nutrition 2010;13:514-521.
27. Frith J, Day C, Robinson L, et al. Potential strategies to improve uptake of exercise interventions in non-alcoholic fatty liver disease. Hepatology 2010;52:112-116.
28. Burgess E, Hassmen P, Pumpa L. Determinants of adherence to lifestyle intervention in adults with obesity: a systematic review. Clinical Obesity 2017;7:123-135.
29. Teixeira P, Carraca E, Marques M, et al. Successful behavior change in obesity interventions in adults: A systematic review of self-regulation mediators. BMC Medicine 2015;13.
30. Wadden T, Letizia K. Predictors of attrition and weight loss in patients treated by moderate and severe caloric restriction', In: Wadden TA, Van Itallie TB (eds.). Treatment of the Seriously Obese Patient. New York: The Guilford Press, 1992.
31. Bonaccio M, Castelnuovo A, Costanzo S, et al. Nutrition knowledge is associated with higher adherence to Mediterranean diet and lower prevalence of obesity. Results from the Moli-sani study. Appetite 2013;68:139-146.
32. Maderuelo-Fernandez J, Recio-Rodriguez J, Patino-Alonso M, et al. Effectiveness of interventions applicable to primary health care settings to promote Mediterranean diet or healthy eating adherence in adults: a systematic review. Preventive Medicine 2015;76:39-55.
33. Middleton G, Keegan R, Smith M, et al. Implementing a Mediterranean diet intervention into a RCT: Lessons learned from a non-Mediterranean based country. The journal of nutrition, health & aging 2015;19:1019-1022.
34. Household disposable income and inequality in the UK: financial year ending 2016. Office for National Statistics 2017:4.
35. Goulet J, Lamarche B, Lemieux S. A nutritional intervention promoting a Mediterranean food pattern does not affect total daily dietary cost in North American women in free-living conditions. Nutrition 2008;138:54-59.
36. Drewnowski A, Eichelsdoerfer P. The Mediterranean diet: does it have to cost more? Public Health Nutrition 2009;12:1621-1628.
37. Macdiarmid J, Loe J, Kyle J, et al. It was an education in portion size. Experience of eating a healthy diet and barriers to long term dietary change. Appetite 2013;71:411-419.
38. Cradock K, OLaighin G, Finucane F, et al. Behaviour change techniques targeting both diet and physical activity in type 2 diabetes: A systematic review and meta-analysis. International Journal of Behavioural Nutrition and Physical Activity 2017;14:18.
41. Bonaccio M, Di Castelnuovo A, Costanzo S, et al. Mass media information and adherence to Mediterranean diet: results from the Moli-sani study. International Journal of Public Health 2012;57:589-597.

Table 1. Baseline characteristics of Mediterranean diet population. Values are means (SD).

Variable	**Mean (SD), n=19**
Gender (% Female)	63.2
White British (%)	89.4
Age (years)	58.5 (10.6)
Married or cohabiting (%)	78.9
Type II diabetes (%)	68.4
Weight (kg)	99.2 (17.0)
BMI (kg/m^2)	36.2 (6.3)
$\leq$30	5.3%
30-34.9	47.4%
35-39.9	26.3%
$\geq$40	21%
MDPS (<5, 6-9, >10)	7.6 (2.5)

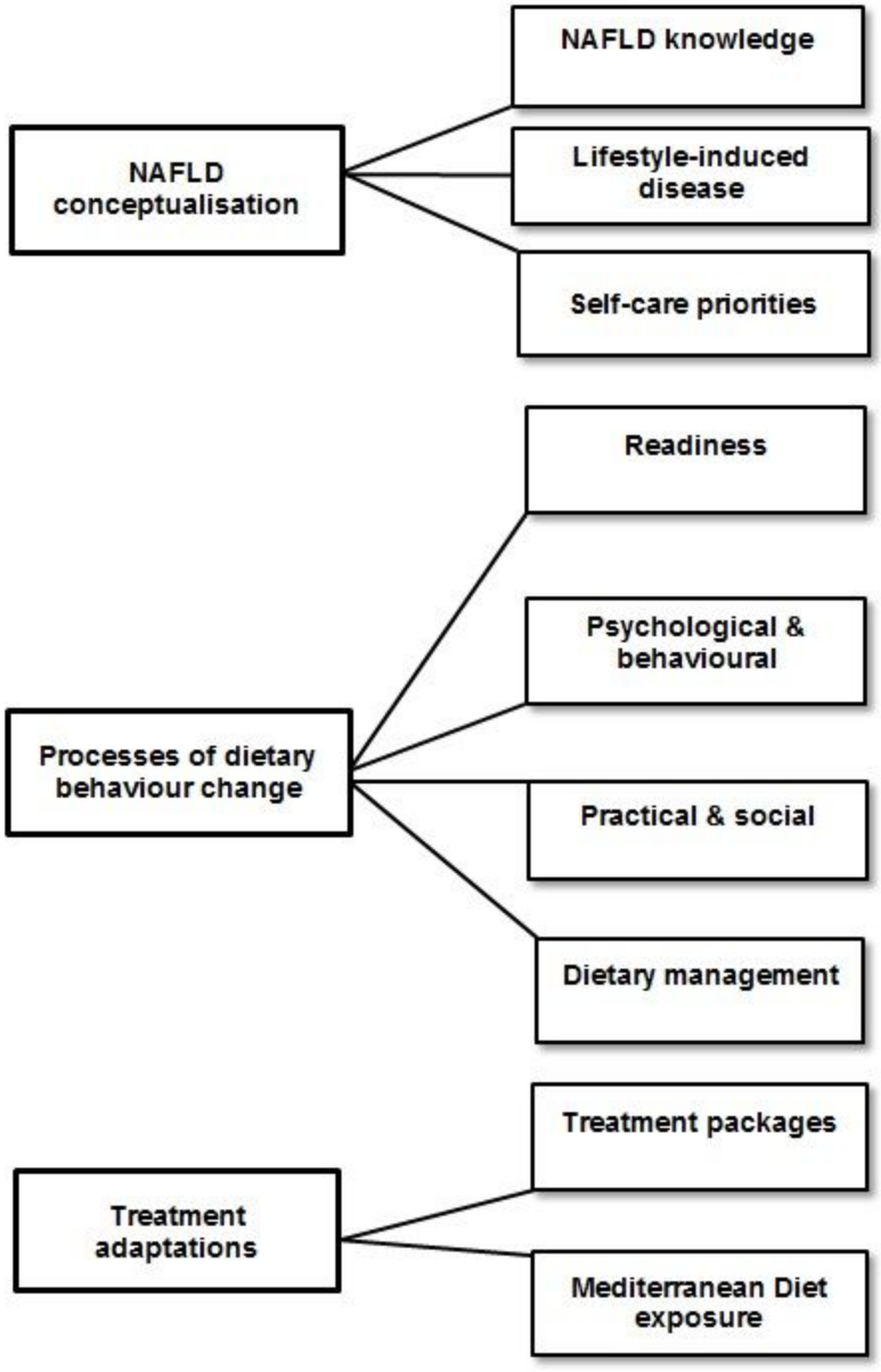
Figure legends

Fig.1. Themes, subordinate-themes, barriers and facilitators

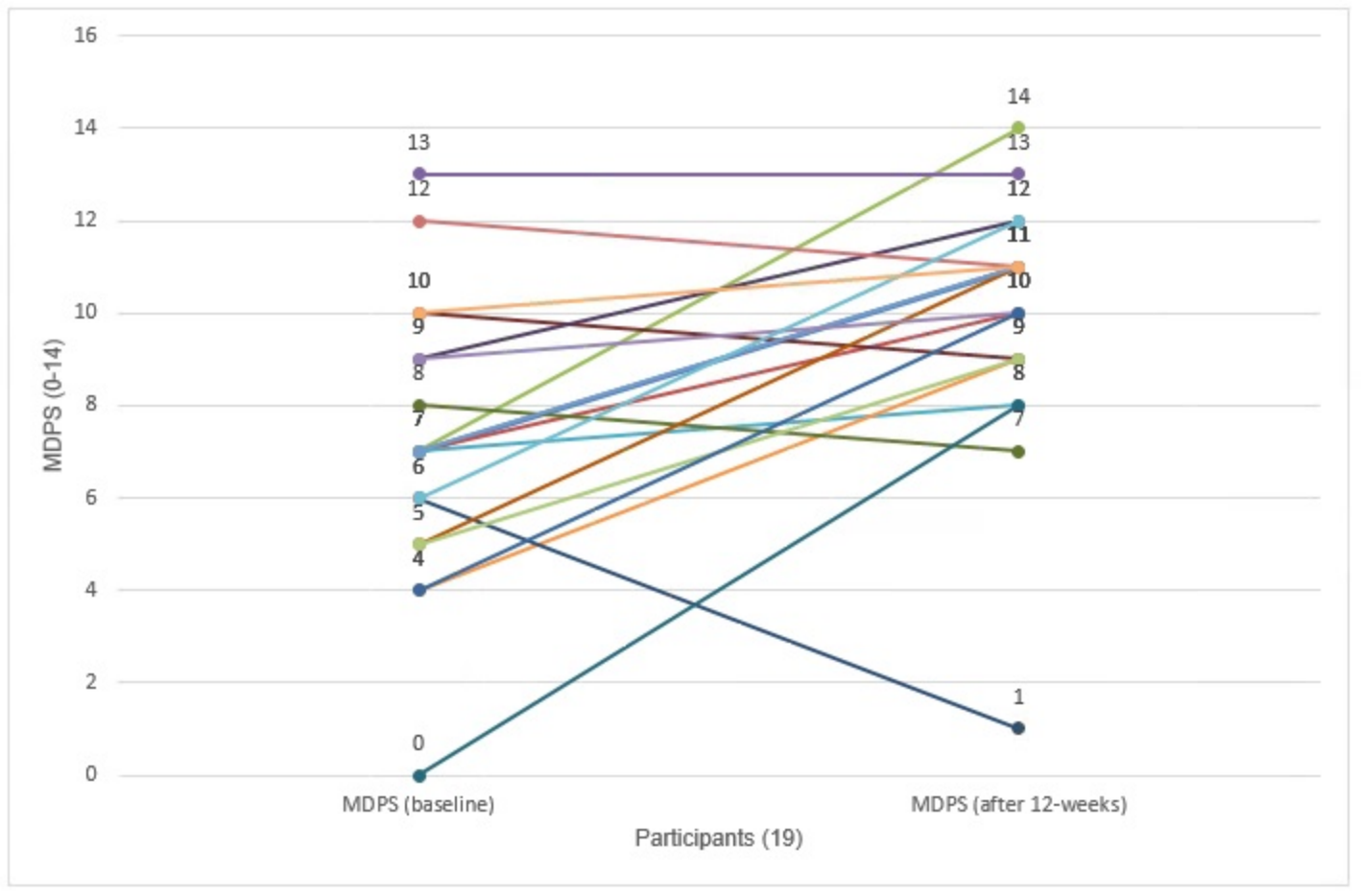
Fig. 2. Mediterranean diet adoption at baseline and after 12-weeks diet intervention.

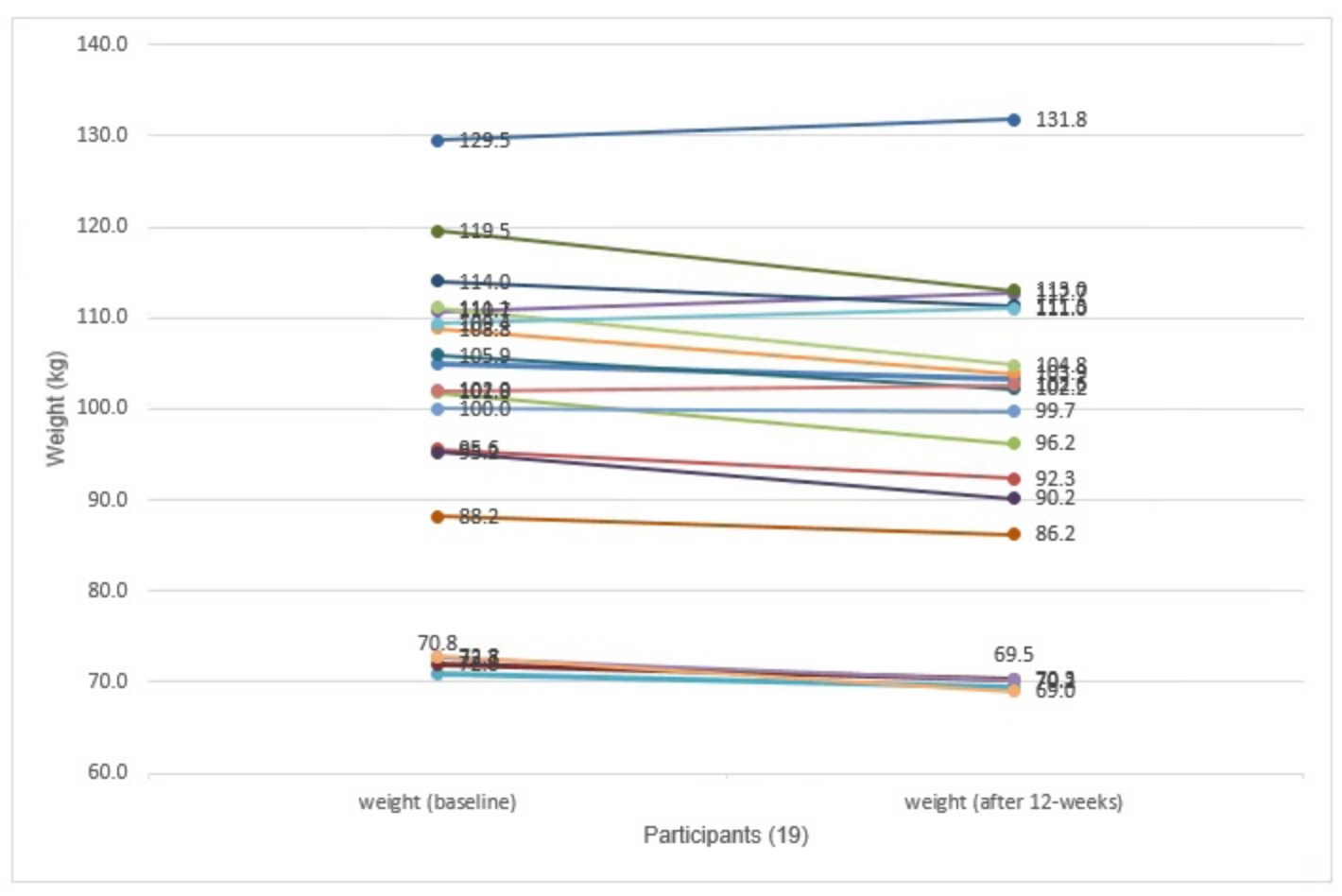
Significance: p=.006 (paired t-test)

Fig. 3. Bodyweight at baseline and after 12-weeks diet intervention. Significance: p=.001 (paired t-test)



	Barriers	Facilitators
NAFLD knowledge	Knowledge deficit: diagnosis, staging, reversal & treatment	
NAFLD conceptualisation	Indeterminate aetiology Social & cultural identity	Belief in lifestyle-induced disease
Self-care priorities	No specificity: self-care priorities Low level of acceptance & activation	Belief that optimal nutrition improves health outcomes
Readiness	Low intrinsic motivation Perceived helplessness Demand for food skills Nutrition unimportant 'Habitual' diet low/high Mediterranean	High intrinsic motivation Self-determination Acceptance Perceived dietary enjoyment
Psychological & behavioural	Life stressors Attitudinal ambivalence Impact of dietary deviations Nutrition attitudes & beliefs	Balanced 'food relationship' Internal locus of control Assertiveness Nutrition attitudes & beliefs
Practical & social	Dietary habits & work patterns Social & cultural influences 'Obesogenic environment' Diet saboteurs & spousal conflict Poorer health & impaired functional status	Self-regulation skills Budget supermarkets & good transport Diet acceptability Enhanced nutrition knowledge/skills Diet supporters
Dietary management	Standardised approaches Taste preferences	Nutrition education & counselling Changes in clinical parameters
Treatment packages	Treatment delivery: telephone contact	Treatment delivery: in-person & online Regular personalised dietary input Joint production of resources
Mediterranean Diet exposure		Promotion in clinical settings Coverage in books & television shows


16
14
12
10
8
6
4
2
0
MDPS (0-14)
13
12
10
9
8
7
6
5
4
0
14
13
12
11
10
9
8
7
1
MDPS (baseline)
MDPS (after 12-weeks)
Participants (19)


140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
Weight (kg)
129.5
131.8
119.5
114.0
105.9
100.0
99.7
96.2
92.3
90.2
88.2
86.2
70.8
69.5
69.0
weight (baseline)
weight (after 12-weeks)
Participants (19)